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Status of Atlantic salmon (*Salmo salar* L.) in Campbellton River, Notre Dame Bay (SFA 4), Newfoundland in 1993

by

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Abstract

The status of Atlantic salmon in Campbellton River in 1993 was determined using a count obtained from a counting fence located on the main stem just above head of tide as well as recreational fishery and biological characteristics data. The assessment was conducted in response to major management changes which were introduced in 1992. Specifically, there was a moratorium on the commercial Atlantic salmon fishery in insular Newfoundland and a quota was placed on recreational catch in each Salmon Fishing Area. The proportion of target spawning requirement of 1,480 salmon achieved for Campbellton River in 1993 was 276%.

Résumé

On a recensé la population de saumon de l'Atlantique dans la rivière Campbellton en 1993 en se fondant sur les résultats obtenus à une barrière de dénombrement installée dans le bras principal de la rivière, juste au-dessus de la ligne extrême des hautes marées, ainsi que sur les données de la pêche récréative et sur des caractéristiques biologiques. Ce recensement fait suite à d'importants changements opérés en 1992, en l'occurrence un moratoire sur la pêche commerciale du saumon de l'Atlantique dans l'île de Terre-Neuve et l'adoption d'un quota sur les prises de la pêche sportive dans chaque zone de pêche du saumon. La proportion de l'échappée-cible de reproducteurs (1 480 saumons) atteinte dans la rivière Campbellton en 1993 était de 276 %.

Introduction

The Campbellton River (Indian Arm River) flows in a northeasterly direction emptying into the sea at Indian Arm, Notre Dame Bay (Fig. 1). In total, Campbellton River has a drainage area of approximately 296 km^2 with an axial length of 40.22 km (Porter et al. 1974) and is about average size for salmon rivers along the northeast coast of insular Newfoundland. The drainage area is also a protected water supply which provides domestic water for the town of Campbellton located at the mouth of the river. The river which is located in Salmon Fishing Area (SFA) 4 (Fig. 2) is in a very productive salmon zone (Table 1) which, on average accounts for 38 percent of all salmon landed by the recreational fishery in the province of Newfoundland. On average throughout the 1980s, Campbellton River attracted an average of 2,094 rod days.

Beginning in 1990 and continuing in 1991, quotas were placed on the commercial salmon fishery in SFAs 2 to 14. In 1992, a major change was introduced when a five-year moratorium was placed on the commercial fishery in insular Newfoundland. In Labrador, commercial fishing continued under quota control with further annual reductions in quotas. In the recreational fishery, a quota system was first introduced in 1992. A quota was assigned for each SFA and not for individual rivers. The recreational fishery in all rivers in each SFA closed to the retention of small salmon when the quota was caught after which hook and release fishing only was permitted until the closure of the angling season. Each SFA quota was subdivided further into quotas for two periods, viz. before July 31 and after July 31. The retention of large salmon was not permitted. Also, a moratorium was placed on the cod fishery in 1992 which should have eliminated salmon bycatches in cod gear.

In 1992, in addition to the moratorium and other reductions in fishing effort; a co-operation agreement was put in place between the Government of Newfoundland and Labrador and the Federal Government of Canada. This agreement called the Cooperation Agreement for Salmonid Enhancement/Conservation (CASEC) was designed to increase the economic opportunities within the province by the improving and maintaining salmonid stocks for angling. The CASEC agreement is comprised of five programs: stock assessment, salmon enhancement, habitat restoration and improvement, cooperative enforcement, and strategic planning and industry development. In 1993, CASEC funded a project on Campbellton River to count upstream migrating adult salmon and downstream migrating smolts as part of the overall experimental design to determine the effects on salmon stocks from reductions in fishing effort. The subsequent adult returns in 1994 and their associated smolt run in 1993 will be used to calculate sea survival which is an important parameter in models used to determine the effects of the reductions in fishing effort on salmon stocks.

In this paper, we examine the status of Atlantic salmon in Campbellton River. Counts obtained from smolt and adult counting fences are used in conjunction with recreational fishery data and biological characteristics data to calculate total river returns and spawning escapements. Stock status is evaluated against a target spawning requirement calculated in terms of fluvial and lacustrine habitats.

Methods

Recreational and commercial fishery data

Catch and effort data from the recreational fishery in Campbellton River were collected by Department of Fisheries and Oceans (DFO) enforcement staff and processed by DFO Science Branch personnel. Procedures for the collection and compilation of commercial and recreational fishery data are described by Ash and O'Connell (1987). Standard weeks were used to ascribe catches to various time periods beginning with standard week 1 from January 1-7, etc to the end of the year.

Smolt and adult salmon counts

Standard conduit smolt and adult counting fences were installed according to the description in Anderson and McDonald (1978). The smolt fence was placed in the main stem of the river, just above the site of the Old Horwood Dam, which was located approximately 300 m upstream from the highway bridge situated at the mouth of the river (Fig. 1). The entire fence was comprised of 29 sections, each 3 m in length, with a standard 2 m * 2 m smolt trap which was installed across a 68 m section of the river on substrate characterized mainly by bedrock with large and small boulders. This site was chosen because of its stable and adequate water levels. During the smolt run the trap was checked and fish released on a regular 2 hour basis from 0600 hrs to 2230 hrs. Also, at each trap check several environmental parameters were collected, ie. water temperature, air temperature, and water level. During the peak smolt run, two 30 cm openings were made in the fence on each side of the smolt trap by removing several conduits and a light colour plywood board was positioned on the substrate to count fish passing through the fence on their downstream migration. Based on the water temperatures and low numbers of smolts trapped at the start of operations probably few if any smolt were missed.

The adult fence was situated just below the Old Horwood Dam on a bedrock substrate in a 25 meter wide section of the river (Fig. 1). The fence had 14 sections (3 m long) and a 2 m * 2 m adult trap. On July 1, a tunnel with a video camera system (VHS format) was installed in the trap giving an overhead view of salmon moving upstream. The video tape was reviewed the next day to count salmon and the count verified by a second individual. This system proved to be very successful in that it allowed salmon to move upstream through the fence on a continuous basis, especially during the night

when visual monitoring was not possible at the trap. Use of the camera system seemed to move salmon through the fence more quickly than in the period prior to its installation. Also, during the daylight hours, a 0.5 m section of the fence next to the trap was opened and monitored to facilitate the upstream migration of salmon. All salmon counted were sized into two categories, viz. small salmon less than 63 cm and large salmon 63 cm or greater. This was done by placing marks 63 cm apart on the floor of the trap/counting device.

Exploitation rates

Exploitation rates for the recreational fishery were derived based on the number of small salmon counted at the fence and the number of salmon reported to have been caught by the recreational fishery. Two exploitation rates were derived due to the SFA quota being subdivided into two periods one for up to July 31 of 3,360 salmon and another after July 31 of 1,440 salmon. Because of this split quota, the recreational fishery in 1993 on Campbellton River took place from June 19 to July 12 and August 1 - 13. Only the number of small salmon counted through the fence during the same period was used for the denominator. Large salmon could not be retained and were not used in the calculations.

Biological characteristics data

Estimated egg depositions in 1993 were based on percentage female and mean weight data which were used to convert target spawning requirements in eggs to spawning requirements in number of fish. These biological characteristics data on adult Atlantic salmon were obtained for Campbellton River by sampling recreational catches in 1992 and 1993. Biological characteristics were collected from the recreational salmon fishery on the Campbellton River in 1992 and 1993 by post-secondary students hired by CEIC through the Challenge Program, under the guidance of DFO technical staff. These students were responsible for collection of information on fork length, weight, sex, scales and ovaries. For small salmon (less than 63 cm in length), mean values for all years combined were used in the calculation of egg deposition. For fish greater than or equal to 63 cm in length (large salmon), mean values for all available data for other rivers along the northeast coast in SFAs 4 and 5 were used. This was necessary because samples from large salmon were unavailable due to the legal requirement to release these fish.

Fecundity was determined from ovaries collected in the recreational fishery. Ovaries were stored in Gilson's fluid until transferred to 10% formalin. Eggs, which for the most part were in early stages of development, were counted directly. The relative fecundity value used to calculate egg deposition for both small and large salmon was 1,775 eggs per kg and represented all data combined from other rivers in SFA 4 for the years 1984-87 (n=173) (O'Connell and Dempson 1991). In 1993, ovaries were

collected as described above from the recreational fishery in Campbellton River and will become part of the fecundity database when egg counts have been completed.

Total river returns, spawning escapement, and egg deposition

TOTAL RIVER RETURNS

Total river returns (TRR) were calculated as follows:

(1) $TRR = RC_b + C$

where,

RC_b = recreational catch below counting fence

C = count of fish at counting fence

SPAWNING ESCAPEMENT

Spawning escapement (SE) was calculated as the difference between the number of fish released from the counting fence (FR)and the recreational catch retained above the fence (RC_a).

(2) $SE = FR - RC_a$

EGG DEPOSITION

Egg deposition (ED) was calculated as follows:

(3) $ED = SE \times PF \times RF \times MW$

SE = number of spawners
PF = proportion of females
RF = relative fecundity (No. eggs/kg)
MW = mean weight of females

O'Connell and Dempson (1991) reported that unpublished evidence exists demonstrating that atresia (non-development of eggs) occurs to varying degrees in insular Newfoundland salmon. This phenomenon has also been reported in Atlantic salmon in the Soviet Union (Melnikova 1964) and in France (Prouzet et al. 1984). Therefore, fecundity values should be regarded as potential values. Since target spawning requirement calculations were based on eggs in early stages of

development, the occurrence of atresia in a given year on a particular river would increase the number of spawners required. Large salmon were not used in calculating the target egg deposition and served as a buffer to requirements.

Accessible rearing habitat

The total surface area of accessible lacustrine habitat available in Campbellton River was determined using an Altek graphic digitizer from 1:50,000 topographic maps (Surveys and Mapping Branch, Department of Energy, Mines and Resources, Ottawa) as described in O'Connell and Dempson (1991).

The amount of classical fluvial parr rearing habitat (Elson 1957) for Campbellton River was developed by the procedure described in Riche (1972). Riche (1972) describes the basis for the procedure used to report accessible parr rearing habitat from river survey files by Porter et al. (1974). Because Campbellton River was not included in the original surveys, a preliminary estimate of the fluvial habitat was obtained from a combination of walking and helicopter surveys and measurements of the axial length of the river from 1:12,500 orthophoto maps compiled from aerial photographs (Lands Branch, Department of Forestry and Agriculture, Government of Newfoundland and Labrador) (pers. comm. P. R Downton).

Target spawning requirements and potential smolt production

Potential smolt production was determined for Campbellton River by multiplying the amount of fluvial and lacustrine habitat by production parameter values derived for each SFA by O'Connell et al. (1991). These values were 3 smolts per unit (100 m^2) of fluvial habitat and 7 smolts per ha of lacustrine habitat.

The target spawning requirement for the Campbellton River was derived using egg deposition rates of 240 eggs per 100 m^2 for fluvial parr rearing habitat (Elson 1957) and 368 eggs per ha for lacustrine habitat (O'Connell et al. 1991). Although these values may be habitat and river specific for river systems from which they were derived, they are used to represent a general baseline which can be applied to the Campbellton River and other rivers in Newfoundland (O'Connell et al. 1991). Target spawning requirement in terms of eggs was converted to adults by the following formula:

TARGET SPAWNING REQUIREMENT

$$(4) \quad \text{No. of small salmon} = \frac{\text{Target no. of eggs}}{\text{Relative fecundity x mean female weight x \% female}}$$

Results

Recreational and commercial fishery data

In 1991, the last year of the commercial fishery in SFA 4, commercial catches were 15,609 small and 6,301 large salmon which were 64.4% and 44.2%, respectively below the 1984-90 means (Table 2).

The recreational salmon fishery in Newfoundland has undergone several changes through the Atlantic Salmon Management Plans over the past several years in an effort to maintain and conserve salmon stocks. Changes in the recreational fishery have included reduced fishing seasons as well as bag limits and zonal quotas. Also, beginning in 1984, the retention of multi-sea winter salmon (fish generally 63 cm or greater) was prohibited. In 1993, the new recreational salmon management guidelines, as they were applied for Insular Newfoundland, are presented in Appendix A.

In 1993, the recreational fishery in SFA 4 similar to other SFAs was divided into two periods with separate opening dates, closing dates and quotas for each. The first open period ran from June 19 to July 11 with a quota of 3,360 and catch of 4,171. The second open period was from August 1 to August 12 with a quota of 1,440 and catch of 1,555. Thus, the total quota was 4,800 and catch was 5,726. In 1992, the fishery opened on June 20 with a quota of 4,800 and catch of 5,290. In 1992, there was a single open period which ran from June 20 to July 24. In 1993, the recreational salmon fishery on Campbellton River had a total of 1,140 rod days (a rod day being a day or any part thereof in which an individual fishes for salmon) for a retained catch of 316 (237 for the first quota and 79 for the second quota) small salmon accounting for 5.62% of rod days and 5.52% of the retained catch for SFA 4 (Table 1). However, angler interest for this river dropped from 3,219 rod days in 1985 to a low of 693 rod days in 1990. Similar to some other salmon rivers in insular Newfoundland, fishing effort on Campbellton increased substantially in 1993. These increases in effort and catch are attributed to anticipated increases in the salmon returns as a result of the closure of the commercial fishery in 1992. In 1992, the recreational fishery on Campbellton River had 800 rod days and a catch of 311 salmon (Table 3).

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During the adult fence operation the river was closed to angling 43 meters above the counting fence at the Old Horwood Dam site and below the fence to saltwater. However, a section of the river referred to as the "V" located at the Old Horwood Dam received the most fishing pressure on the lower section of the river. This was mainly due to the easy access from the main highway and relatively good catches at this site. The next site of extensive angling was centred around the lower part of Second Pond resulting from an upgraded forestry road and new bridge constructed in 1992 which provided for easier access to this part of the river. The main stem between Fourth Pond and Indian Arm Pond and the lower portions of Indian Arm Brook and Neyles Brook were the other popular fishing sites for this system.

Smolt and adult salmon counts

In 1993, a total of 31,577 smolts and 1,386 kelts passed through the downstream fence along with several other species such as smelt and brook trout (Table 4). The peak of the smolt run occurred in standard week 23 which accounted for 31.4 percent of the total (Fig. 3). During the downstream salmon smolt migration it was noticed by project personnel and local residents of Campbellton that gulls were feeding heavily on fish from the lower section of the river and in the estuary. The extent of feeding on salmon smolts was somewhat difficult to estimate in that feeding took place on a continuous basis throughout daylight hours. Of course, this has been noted by local residents in other years and other river systems, ie. Highlands River.

In 1993, a total of 4,001 grilse and 145 large salmon were counted as they passed upstream through the adult fence (Table 5). The first adult salmon was counted on 13 June and the last fish was counted on 7 September. In 1993, the percentage of small salmon in the run was 96.5%. Standard week 27 had the highest number (1,351) of salmon pass through the fence at 32.6%, with combined standard weeks 26-28 accounting for 74.8 percent of the total run (Fig. 4). Water temperatures ranged from a low of 3 °C in early May to a peak of about 22 °C in mid-August (Fig. 5). Before the adult fence was removed on 7 September, the portion of the river downstream from the fence was checked visually by swimming for any adult salmon. No salmon were observed remaining in the river downstream from the fence. Therefore, it is assumed that a complete upstream migration count of adult salmon was achieved.

Exploitation rates

In 1993, a total of 4,001 small salmon passed through the counting fence and there was a catch of 316 salmon in the recreational fishery above the fence. There were no salmon caught below the fence. The exploitation rate in the 1993 recreational fishery was 7.9% (95% CI=4.7%, 12.6%). This is divided into 5.9% for the early fishery and 2.0% for the fishery in August. The exploitation rate based on the fish counted into the river and angling catches up to the July 11 is 8.0%.

Biological Sampling

In 1992 and 1993, 23 and 91 fish were sampled, respectively (Table 6). Since sampling numbers were somewhat low for 1992 the data from both years were combined. Overall mean fork length of the grilse-only fishery for the Campbellton River was 52.6 cm and 82% of aged fish had a freshwater life of 3 years. Two fish that were sampled in 1992 had previously spawned and were within the retention fork length limit set for the recreational fishery. Also, one fish was identified as being a precocious smolt (returned back into the river in the same summer of entry to sea) and female.

The percentage of female salmon sampled from the recreational fishery in 1992-93 was 75% (Table 6). The mean weight for female grilse was 1.493 kg (N=61 and SD=0.215). There were no samples for large salmon available in 1992 and 1993 from Campbellton River due to the mandatory release of large salmon; consequently, default values for mean weight and percent female of large salmon from Terra Nova and Gander rivers of 3.41 kg and 88% female were used (O'Connell and Ash 1994). Default values of 1,775 eggs per kg were used to represent fecundity values for 1SW salmon from Campbellton River (O'Connell and Dempson 1991).

Accessible rearing habitat

The total amount of fluvial parr rearing habitat for Campbellton River is 5,960 units (a unit being 100 m^2). The lacustrine habitat available for parr rearing on Campbellton River is 4037.3 ha. The ratio of lacustrine to fluvial habitat is 76.74 which is lower than the mean for other SFA 4 rivers (O'Connell and Dempson 1991).

Total river returns, spawning escapement, and egg deposition

Year	Total returns		Spawning escapements		Egg deposition (No. x 10^6)		% of target
	G	LS	G	LS	G	LS	
1993	4,001	145	3,685	145	7.27	0.772	276

Note: default values derived by O'Connell and Ash (1994) for mean weight and sex ratio were used to calculate egg deposition for large salmon. G and LS stand for grilse and large salmon, respectively.

Target spawning requirements and potential smolt production

The estimated target spawning requirement for Campbellton River in terms of eggs as well as adult salmon were estimated as follows:

	Lacustrine	Fluvial	Total
Accessible habitat	4037.3	5,960	-
Eggs (No. x 10^6)	1.486	1.430	2.916
Small salmon (No.)	753	725	~1480

The target spawning requirement was calculated in terms of small salmon only, similar to other northeast coast Newfoundland rivers (O'Connell and Dempson 1991). As pointed out earlier, egg deposition from large salmon was considered as a buffer to the estimate of spawning requirement.

Estimated potential smolt production were as follows:

Fluvial smolt = 3 smolts/unit * 5960 units = 17,880
Lacustrine smolt = 7 smolts/ha * 4,037.3 ha = 28,261

Total potential smolt production = 46,141

Discussion

For Campbellton River, there was no habitat survey available (Porter et al. 1974). Thus, the habitat values given in this paper should be regarded as preliminary and will be subject to further review. The Campbellton River watershed has had extensive logging activity in the past. Especially in the early 1900's when a 400 m long, 10 m high dam was erected by the Horwood Lumber Company near the mouth of the river to divert water into a 350 m rock-cut channel to run a pulp mill and hydro plant. At this time this company had timber rights to 596 km² and used the river as a means to float logs to the mill. However, this operation was short lived since the dam broke in 1916 and the company went into bankruptcy. Logging continued in and around the Campbellton River up to 1966 when 22 small dams were removed by Price (Nfld.) Ltd. under the supervision of the Department of Fisheries and Oceans. Even the structures from these historical logging activities are still visible in the remains of dams and tree trunks scattered at various points along the river. The remains of several dams located on the Crooked Brook tributary, which empties into Second Pond, still pose partial obstruction to migrating salmon during low water levels. In 1961, the upper watershed near Shirley Lake and Silt Lake was completely destroyed by fire,

which only now has returned to a normal forest growth. The effect of these activities on the production of salmon in the system are unknown.

Since the habitat in Campbellton River has not been completely surveyed the calculated target spawning requirement may be an over- or under-estimate. The total number of adult salmon spawning in 1993 resulted in an egg deposition that was 276% over the target suggesting the target may be underestimated. It was noted during the helicopter survey that many of the spawning areas on the main stem were located between relatively small and shallow ponds. These shallow ponds may provide for an optimal utilization of rearing habitat and a higher rearing capacity much closer to that of the classical fluvial habitat may be more appropriate. Therefore caution must be used when referring to the target spawning value until a full habitat survey is completed.

For Campbellton River, the smolt production of 31,577 for 1993 is 31.6% below the calculated potential smolt production capacity of 46,141. The modal smolt age for Campbellton River salmon is 3 years and thus, the 1993 smolt run is derived mainly from adults that spawned in the fall of 1989. For most Newfoundland rivers, spawning escapements were the lowest on record in the period 1989-91 (Dempson and O'Connell 1993). Escapements on northeast coast Newfoundland rivers rose beginning in 1992 with the beginning of the commercial salmon fishing moratorium and smolt production stemming from spawning escapements in post-moratorium years may be much closer to this potential figure.

Cautions associated with the parameter values used to calculate the target spawning requirement have been discussed previously by O'Connell et al. (1991), O'Connell and Dempson (1991), O'Connell and Ash (1994) and will not be dealt with in detail here. The comments in O'Connell and Ash (1994) on further substantiation of parameter values for calculations related to egg deposition apply as well to Campbellton River. Also, it should be kept in mind that inaccuracies in catch statistics, losses to due poaching, losses due to hook and release mortality, and losses from natural mortality will influence the results.

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Table 1. The total number and percent of rod days and retained fish for Atlantic salmon angled on scheduled rivers in SFA 4, 1993.

Schedule salmon rivers for SFA 4	Total rod days	Percent rod days	Total retained catch	Percent catch
East Brook (Burlington River)	123	0.61%	35	0.61%
Indian Brook (Indian River)	1,207	5.95%	420	7.33%
Riverhead Brook (west brook)	836	4.12%	381	6.65%
South Brook	647	3.19%	263	4.59%
Tommy's Arm River	589	2.90%	179	3.13%
Northwest Arm River	74	0.36%	14	0.24%
West Arm Brook (Western Arm)	507	2.50%	131	2.29%
Newbay River (Point Leamington)	917	4.52%	340	5.94%
Charles Brook	63	0.31%	13	0.23%
Northern Arm Brook	522	2.57%	80	1.40%
Peters River	127	0.63%	18	0.31%
Exploits River	4,849	23.90%	1,655	28.90%
Campbellton River (Indian Arm Brook)	1,140	5.62%	316	5.52%
Dog Bay River (Horwood)	589	2.90%	151	2.64%
Gander River	5,408	26.65%	1,271	22.20%
Ragged Harbour River	1,122	5.53%	280	4.89%
Anchor Brook	409	2.02%	42	0.73%
Deadmans Brook	622	3.07%	74	1.29%
Windmill Brook	540	2.66%	63	1.10%
Total	20,291	100.00%	5,726	100.00%

Table 2. Number of fishers, gear units and catches of Atlantic salmon in the commercial fishery for SFA 4 and Insular Newfoundland based on 1984-90 means. Gear units refer to length of net.

Year	Salmon fishing Area 4						Insular Newfoundland					
	Number of commercial fisherman	Gear units (91.5 m)	Catch metric tons		Catch numbers		Number of commercial fisherman	Gear units (91.5 m)	Catch metric tons		Catch numbers	
			Small	Large	Small	Large			Small	Large	Small	Large
1984	892	3,124	73	50	38,857	10,976	3,065	11,008	241	240	130,131	54,283
1985	695	2,768	68	43	37,957	10,019	2,480	9,878	348	242	191,216	57,537
1986	696	2,782	119	81	59,902	17,047	2,480	9,916	392	282	200,267	60,699
1987	693	2,764	109	71	54,935	15,087	2,480	9,784	434	357	225,025	77,945
1988	682	2,728	68	35	36,016	8,179	2,380	9,520	249	191	134,562	43,581
1989	679	2,716	85	48	46,988	10,834	2,360	9,440	266	190	148,297	46,261
1990	669	2,674	62	31	32,648	6,940	2,320	9,270	171	180	92,554	39,497
Means (84-90) SFA 4	715	2,794	83	51	43,900	11,297	2,509	9,831	300	240	160,293	54,258
1991	647	2,588	30	27	15,609	6,301	2,240	8,992	136	130	74,202	32,604
% drop from 84-90 means for 1991 fishing year	9.53%	7.36%	64.04%	47.35%	64.44%	44.23%	10.73%	8.53%	54.69%	45.90%	53.71%	39.91%

Note : In 1990 and 1991 a quota system was in placed and accounted for earily clousres for several SFA 's, during their fishing season, although set quota levels were not reached for SFA 4 and Insular Newfoundland for both years. Therefore slightly higher catches may have resulted in Insular Newfoundland.

Table 3. The total rod days, total catch and catch per unit effort (CPUE) for Atlantic salmon retained in the recreational fishery for Insular Newfoundland ,Salmon Fishing Area 4 and the Campbellton River from 1953 to 1993.

	Rod days			Total catch			CPUE		
Year	Insular NFLD	SFA 4	Campbellton River	Insular NFLD	SFA 4	Campbellton River	Insular NFLD	SFA 4	Campbellton River
1953	27,955	8,630	346	8,226	3,485	126	0.29	0.40	0.36
1954	16,974	7,344	587	3,630	1,600	102	0.21	0.22	0.17
1955	11,183	5,125	56	5,098	2,616	61	0.46	0.51	1.09
1956	33,532	10,672	341	8,269	4,350	119	0.25	0.41	0.35
1957	17,514	8,789	291	8,617	4,950	105	0.49	0.56	0.36
1958	16,593	5,888	592	10,054	5,001	447	0.61	0.85	0.76
1959	17,570	6,321	325	8,685	4,220	303	0.49	0.67	0.93
1960	17,530	7,051	313	7,366	3,950	265	0.42	0.56	0.85
1961	13,730	5,277	209	4,778	2,280	146	0.35	0.43	0.70
1962	21,641	8,842	397	9,912	4,879	147	0.46	0.55	0.37
1963	26,824	10,910	1,242	10,673	4,042	421	0.40	0.37	0.34
1964	34,886	15,608	1,066	16,281	7,917	496	0.47	0.51	0.47
1965	34,083	13,749	647	12,443	4,551	468	0.37	0.33	0.72
1966	34,073	15,249	881	13,745	6,627	689	0.40	0.43	0.78
1967	38,067	13,915	815	9,569	4,226	487	0.25	0.30	0.60
1968	40,004	15,318	1,577	16,616	6,139	743	0.42	0.40	0.47
1969	40,347	13,807	992	16,470	4,138	534	0.41	0.30	0.54
1970	38,933	15,759	660	15,665	4,896	437	0.40	0.31	0.66
1971	38,417	11,379	622	13,151	3,841	299	0.34	0.34	0.48
1972	33,487	10,778	452	12,798	3,468	210	0.38	0.32	0.46
1973	46,180	14,544	1,344	19,450	6,759	971	0.42	0.46	0.72
1974	67,894	22,038	1,956	15,689	5,455	505	0.23	0.25	0.26
1975	60,191	22,384	1,768	16,304	6,109	487	0.27	0.27	0.28
1976	64,853	24,787	2,042	16,722	6,871	834	0.26	0.28	0.41
1977	69,057	28,117	2,134	22,561	9,482	912	0.33	0.34	0.43
1978	63,599	24,131	1,314	20,339	9,276	429	0.32	0.38	0.33
1979	50,199	21,496	53	18,228	8,353	23	0.36	0.39	0.43
1980	66,625	25,172	2,293	24,093	9,921	1,112	0.36	0.39	0.48
1981	77,884	32,282	2,950	30,980	13,897	1,549	0.40	0.43	0.53
1982	85,200	32,929	1,674	26,518	10,231	473	0.31	0.31	0.28
1983	82,167	26,649	1,619	22,311	9,251	597	0.27	0.35	0.37
1984	79,740	29,633	2,657	24,878	9,915	992	0.31	0.33	0.37
1985	82,783	34,329	3,219	26,527	12,190	782	0.32	0.36	0.24
1986	79,009	31,650	1,791	24,182	9,293	422	0.31	0.29	0.24
1987	47,809	18,564	803	13,013	5,453	169	0.27	0.29	0.21
1988	73,566	27,413	1,837	23,960	9,854	636	0.33	0.36	0.35
1989	53,862	17,767	854	11,525	3,786	148	0.21	0.21	0.17
1990	64,494	23,533	693	17,409	5,661	106	0.27	0.24	0.15
1991	52,173	21,999	693	11,132	4,892	126	0.21	0.22	0.18
1992	39,242	15,097	800	12,271	5,290	311	0.31	0.35	0.39
1993	58,943	20,291	1,140	14,947	5,726	316	0.25	0.28	0.28
Mean	46,800.32	17,688.20	1,123	15,245.98	6,215.63	451.34	0.35	0.38	0.45

Table 4 . Downstream migrations enumerated at the portable counting trap on the Campbellton River ,1993.

Date	Salmon Parr	Salmon Smolt	Precocious Salmon smolt	Salmon Kelt	Resident Brook trout	Sea run Brook trout	Smelt	Eel
14-May	0	0	0	0	0	0	1	0
15-May	0	0	1	0	1	0	20	0
16-May	1	1	1	11	24	0	25	1
17-May	6	26	1	101	86	4	25	0
18-May	18	5	0	67	93	2	71	0
19-May	31	31	0	75	86	0	43	0
20-May	23	62	4	107	73	0	61	0
21-May	54	146	0	60	116	0	27	0
22-May	58	594	9	82	126	1	16	0
23-May	55	963	5	67	144	1	8	1
24-May	230	1311	0	74	202	5	185	1
25-May	93	1449	4	112	141	0	533	0
26-May	37	1348	5	86	59	0	375	0
27-May	7	796	1	35	31	0	588	0
28-May	12	926	1	30	16	0	700	0
29-May	12	646	2	4	11	0	582	0
30-May	7	754	3	11	6	0	1047	0
31-May	7	661	1	9	8	0	1099	0
01-Jun	1	882	7	7	16	0	665	0
02-Jun	2	1851	8	16	21	0	394	0
03-Jun	1	1351	0	16	24	0	124	0
04-Jun	1	800	0	28	17	0	248	0
05-Jun	4	1218	0	3	18	0	155	0
06-Jun		793	0	72	22	2	135	0
07-Jun	5	1868	1	29	35	0	58	0
08-Jun	1	2140	1	14	33	0	34	0
09-Jun	6	1448	1	9	34	0	19	0
10-Jun	7	1648	2	4	22	0	17	0
11-Jun	2	1426	0	2	34	0	19	1
12-Jun		471	0	1	10	0	7	0
13-Jun	2	199	0	2	4	0	8	0
14-Jun		225	0	1	4	0	2	0

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Table 4 . Downstream migrations enumerated at the portable counting trap on the Campbellton River ,1993.

Date	Salmon Parr	Salmon Smolt	Precocious Salmon smolt	Salmon Kelt	Resident Brook trout	Sea run Brook trout	Smelt	Eel
15-Jun	2	703	0	3	1	0	2	0
16-Jun	1	933	0	164	6	0	8	1
17-Jun	1	561	0	25	2	0	5	0
18-Jun	1	992	0	7	9	0	1	0
19-Jun	2	1018	0	10	1	0	5	0
20-Jun	6	658	0	4	3	0	2	0
21-Jun	1	58	0	29	2	0	2	0
22-Jun	1	89	0	3	0	0	0	0
23-Jun	0	185	0	0	0	0	0	0
24-Jun	0	12	0	0	0	0	0	0
25-Jun	0	36	0	1	0	0	0	0
26-Jun	0	37	0	1	0	0	0	0
27-Jun	0	33	0	0	7	0	0	0
28-Jun	0	34	0	4	4	0	0	0
29-Jun	0	39	0	0	7	0	0	0
30-Jun	0	40	0	0	3	0	0	0
01-Jul	0	34	0	0	4	0	0	0
02-Jul	0	31	0	0	12	0	0	0
03-Jul	0	9	0	0	0	0	0	0
04-Jul	0	25	0	0	0	0	0	0
05-Jul	0	10	0	0	0	0	0	0
06-Jul	0	0	0	0	0	0	0	0
07-Jul	0	0	0	0	0	0	0	0
08-Jul	0	1	0	0	0	0	0	0
09-Jul	0	0	0	0	0	0	0	0
10-Jul	0	0	0	0	0	0	0	0
Total	**698**	**31,577**	**58**	**1,386**	**1,578**	**15**	**7,316**	**5**

Table 5. Upstream migration of adult Atlantic salmon through the counting trap in the Campbellton River, 1993.

Date	Salmon parr	Precocious smolts	Small salmon	Large salmon	Resident trout	Eel
10-Jun	0	0	0	0	0	0
11-Jun	0	0	0	0	0	0
12-Jun	0	0	0	0	0	0
13-Jun	0	0	4	0	0	0
14-Jun	0	0	1	0	0	0
15-Jun	0	0	4	0	0	0
16-Jun	0	0	0	0	0	0
17-Jun	0	0	5	0	0	0
18-Jun	0	0	3	0	0	0
19-Jun	0	0	8	0	0	0
20-Jun	0	0	8	0	0	0
21-Jun	0	0	24	0	0	0
22-Jun	0	0	20	3	0	0
23-Jun	0	0	50	0	0	0
24-Jun	0	0	104	3	0	0
25-Jun	0	0	103	0	0	0
26-Jun	0	0	191	3	0	0
27-Jun	0	0	44	0	7	0
28-Jun	0	0	83	7	4	0
29-Jun	0	0	172	12	7	0
30-Jun	0	0	136	7	3	0
01-Jul	0	0	294	11	16	0
02-Jul	0	0	279	12	28	0
03-Jul	0	0	234	5	13	0
04-Jul	0	0	200	9	18	0
05-Jul	0	0	90	1	13	0
06-Jul	0	0	285	9	3	0
07-Jul	0	0	137	3	5	0
08-Jul	0	0	126	3	10	0
09-Jul	0	0	102	3	3	0
10-Jul	0	0	165	3	6	0
11-Jul	0	0	100	2	9	0
12-Jul	0	0	99	4	5	0
13-Jul	0	0	119	5	3	0
14-Jul	0	0	69	2	2	0
15-Jul	0	0	73	6	2	0
16-Jul	0	0	1	0	0	0
17-Jul	0	0	77	3	0	0
18-Jul	0	0	106	5	0	0
19-Jul	0	0	73	2	1	0
20-Jul	0	0	36	0	0	0
21-Jul	0	0	19	0	1	0
22-Jul	0	0	28	2	2	0
23-Jul	0	0	40	3	2	0
24-Jul	0	0	39	3	1	0
25-Jul	0	0	31	1	1	0
26-Jul	0	0	14	0	0	0
27-Jul	0	0	14	0	0	0
28-Jul	0	0	12	0	1	0
29-Jul	0	0	5	0	0	0
30-Jul	0	0	6	0	0	0
31-Jul	0	0	12	0	0	0

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Table 5. Upstream migration of adult Atlantic salmon through the counting trap in the Campbellton River, 1993.

Date	Salmon parr	Precocious smolts	Small salmon	Large salmon	Resident trout	Eel
01-Aug	0	0	8	0	0	1
02-Aug	0	0	6	1	0	0
03-Aug	0	0	8	0	0	0
04-Aug	0	0	17	0	0	0
05-Aug	0	0	2	0	0	0
06-Aug	0	0	9	0	0	0
07-Aug	0	0	11	0	0	0
08-Aug	0	0	5	1	0	1
09-Aug	0	0	14	3	1	0
10-Aug	0	0	7	0	1	0
11-Aug	0	0	4	0	0	0
12-Aug	0	0	3	0	1	2
13-Aug	0	0	7	0	0	0
14-Aug	0	0	1	0	0	0
15-Aug	0	0	8	1	0	0
16-Aug	0	0	5	1	2	1
17-Aug	0	0	3	1	1	1
18-Aug	0	0	1	0	3	0
19-Aug	0	0	0	0	5	0
20-Aug	0	0	4	0	3	0
21-Aug	0	0	3	0	0	0
22-Aug	0	0	4	1	4	0
23-Aug	0	1	3	0	2	0
24-Aug	0	0	3	0	0	0
25-Aug	0	0	0	1	1	0
26-Aug	0	0	0	0	1	0
27-Aug	1	0	3	0	0	0
28-Aug	0	0	0	0	0	0
29-Aug	0	1	1	0	2	1
30-Aug	0	0	4	0	1	2
31-Aug	0	0	1	0	4	0
01-Sep	0	0	1	0	1	0
02-Sep	0	0	2	0	1	0
03-Sep	2	0	3	1	3	0
04-Sep	0	0	2	0	5	2
05-Sep	0	0	2	2	4	2
06-Sep	0	0	0	0	7	1
07-Sep	0	0	1	0	0	0
Total	3	2	4001	145	219	14

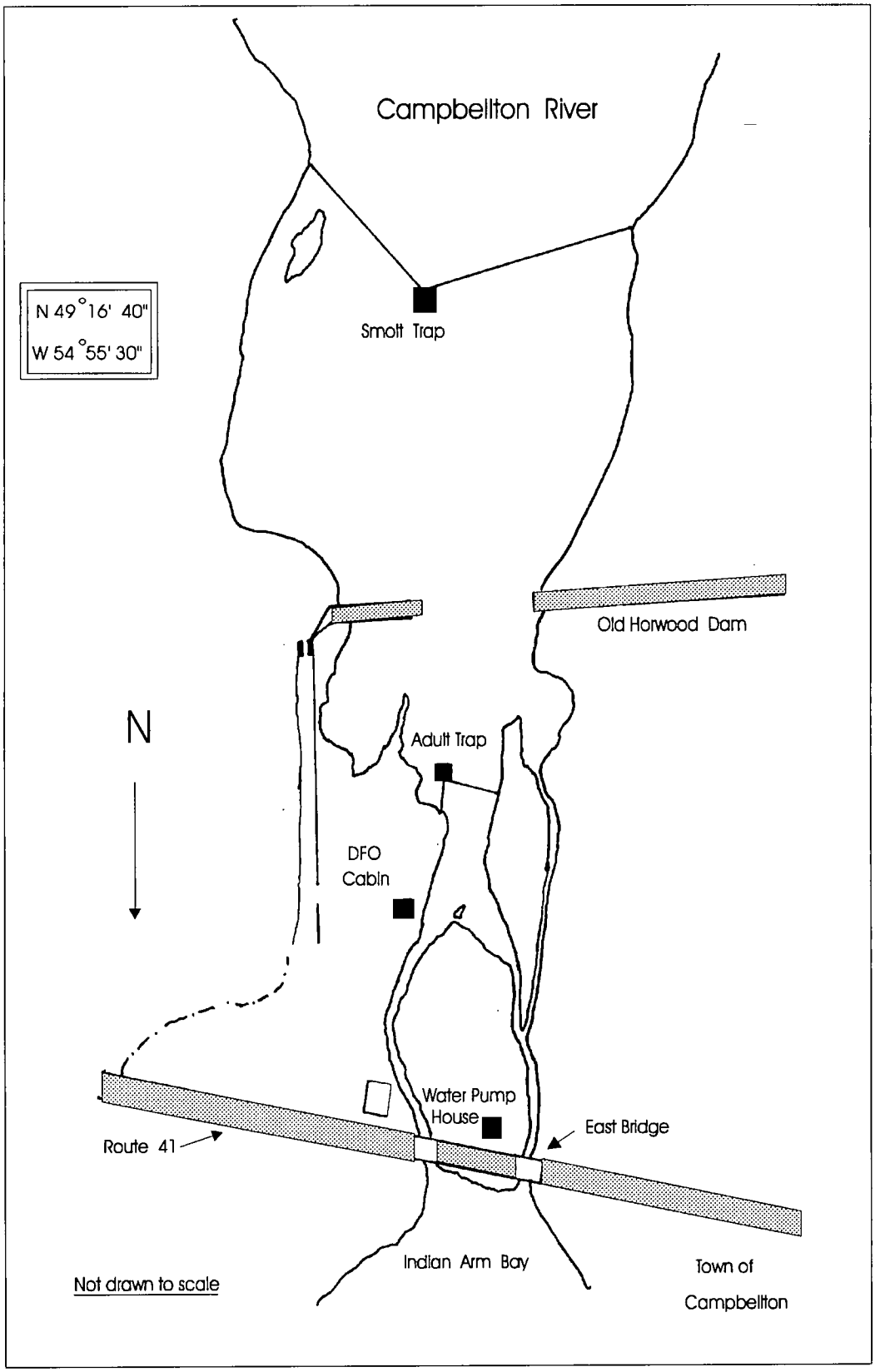
Table 6. Biological characteristics of Atlantic salmon collected from the recreational salmon fishery in Campbellton River, 1992-93.

Year	Fork length			Whole weight			Percent	Percent at river age				Percent Sea age	
	Number	STD	Mean	Number	STD	Mean	Female	2	3	4	5	1 Virgin	Spawners
1992	23	4.83	53.1	10	0.39	1.58	77.8	8.7	65.2	17.4	8.7	91.3	8.7
1993	91	4.71	52.5	86	0.26	1.52	73.9	4.5	86.4	9.1		98.9	1.1
92-93 Combined	114	3.45	52.6	96	0.28	1.53	74.5	5.4	82.0	10.8	1.8	97.25	2.75

Note ; One female fish sampled in 1992 was precocious with a river age of 5 years and fork length of 42 cm.

Gutted weight fish were converted to Whole weight as follows ; WW= (GW * 1.086) + 0.0812

Figure 1. Location of Portable Counting Traps on the Campbellton River, 1993.



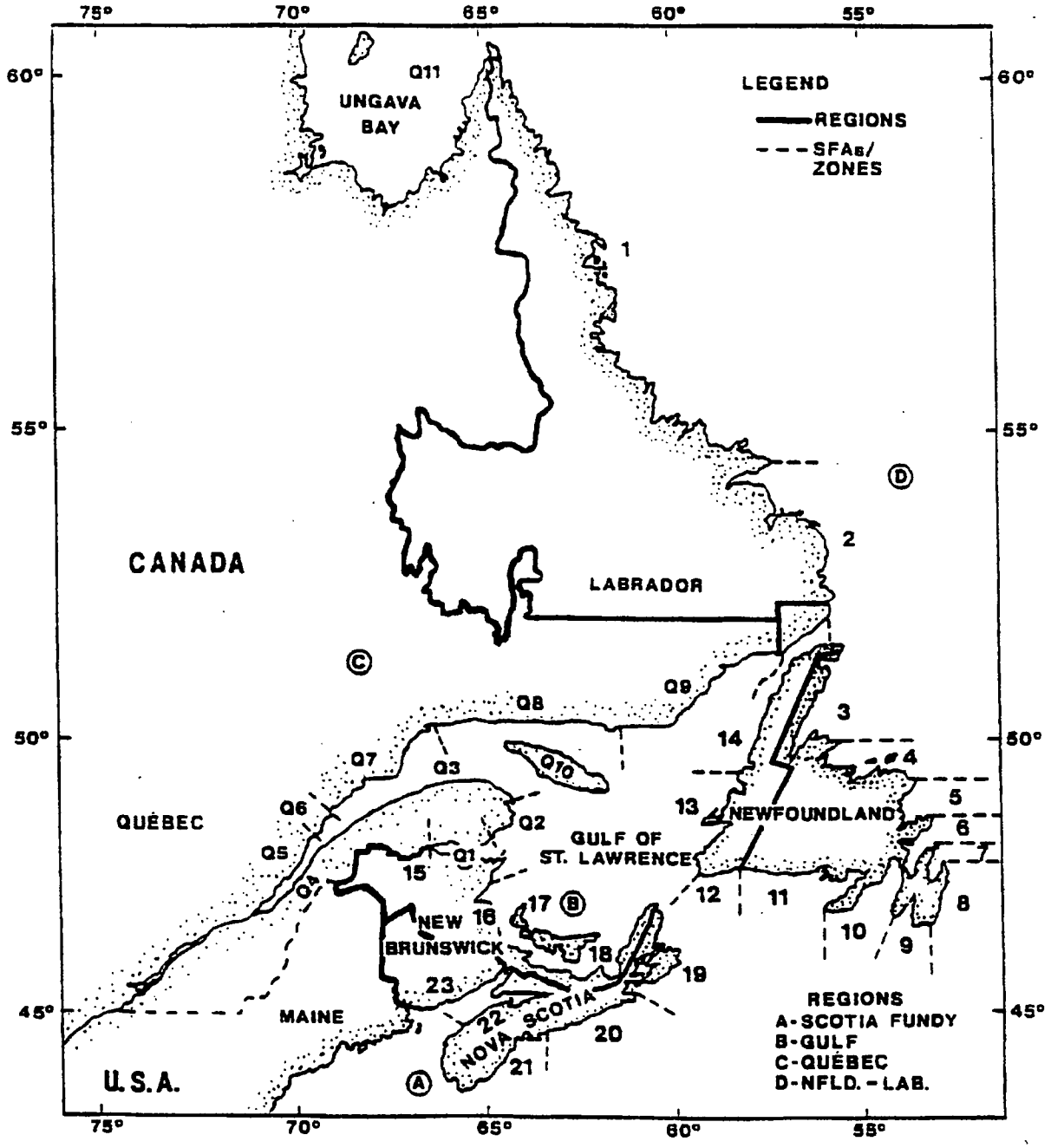


Fig. 2 Map of Atlantic Provinces of Canada showing Salmon Fishing Areas (SFAs) 1-23, Salmon Management Zones of Quebec (Qs) 1-11, and regional boundaries. The Newfoundland Region is comprised of SFAs 1-11.

Figure 3. Atlantic salmon smolts enumerated on their downstream migration in Campbellton River, 1993.

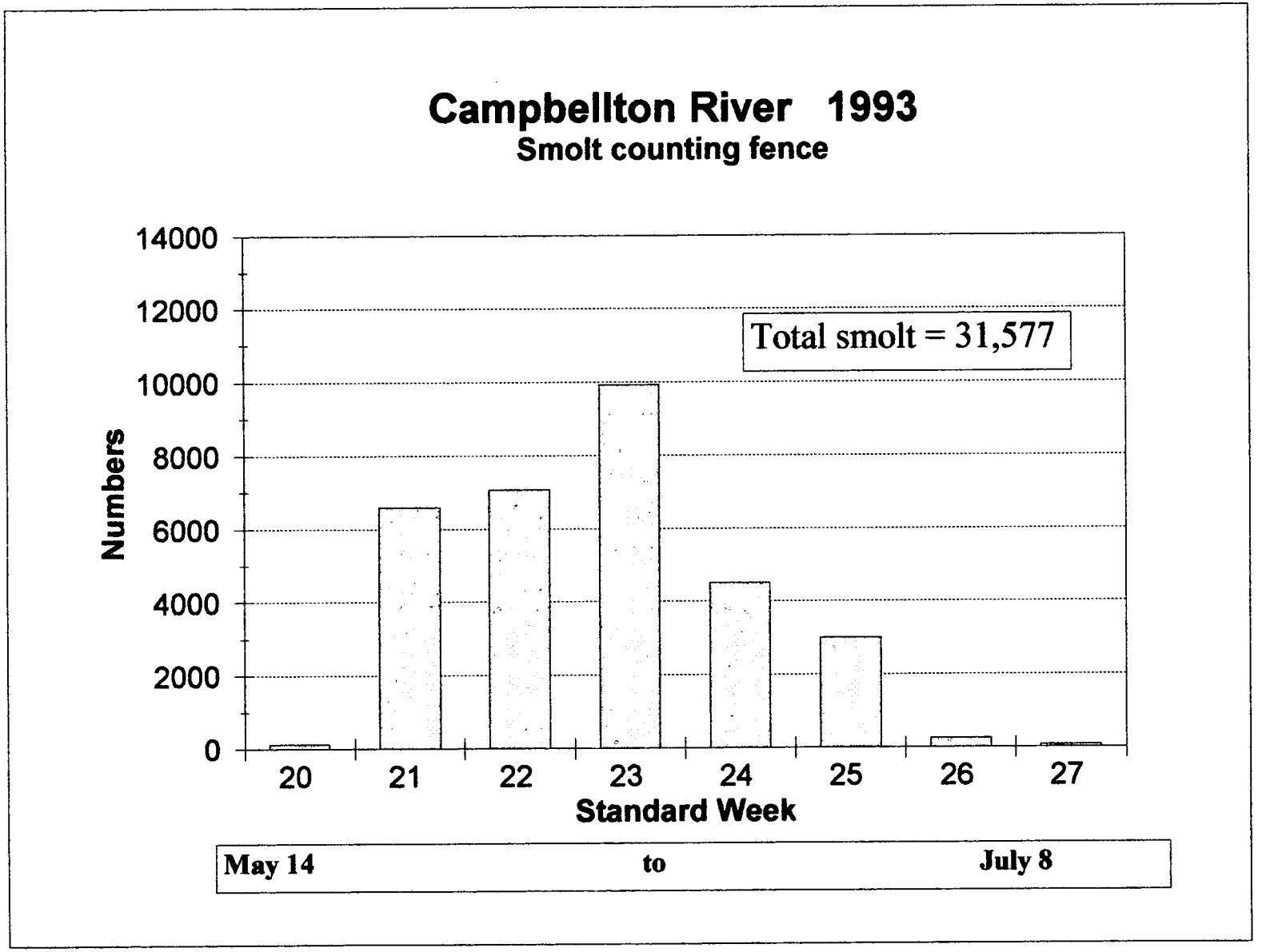


Figure 4. Atlantic salmon adults enumerated on their upstream migration in the Campbellton River, 1993.

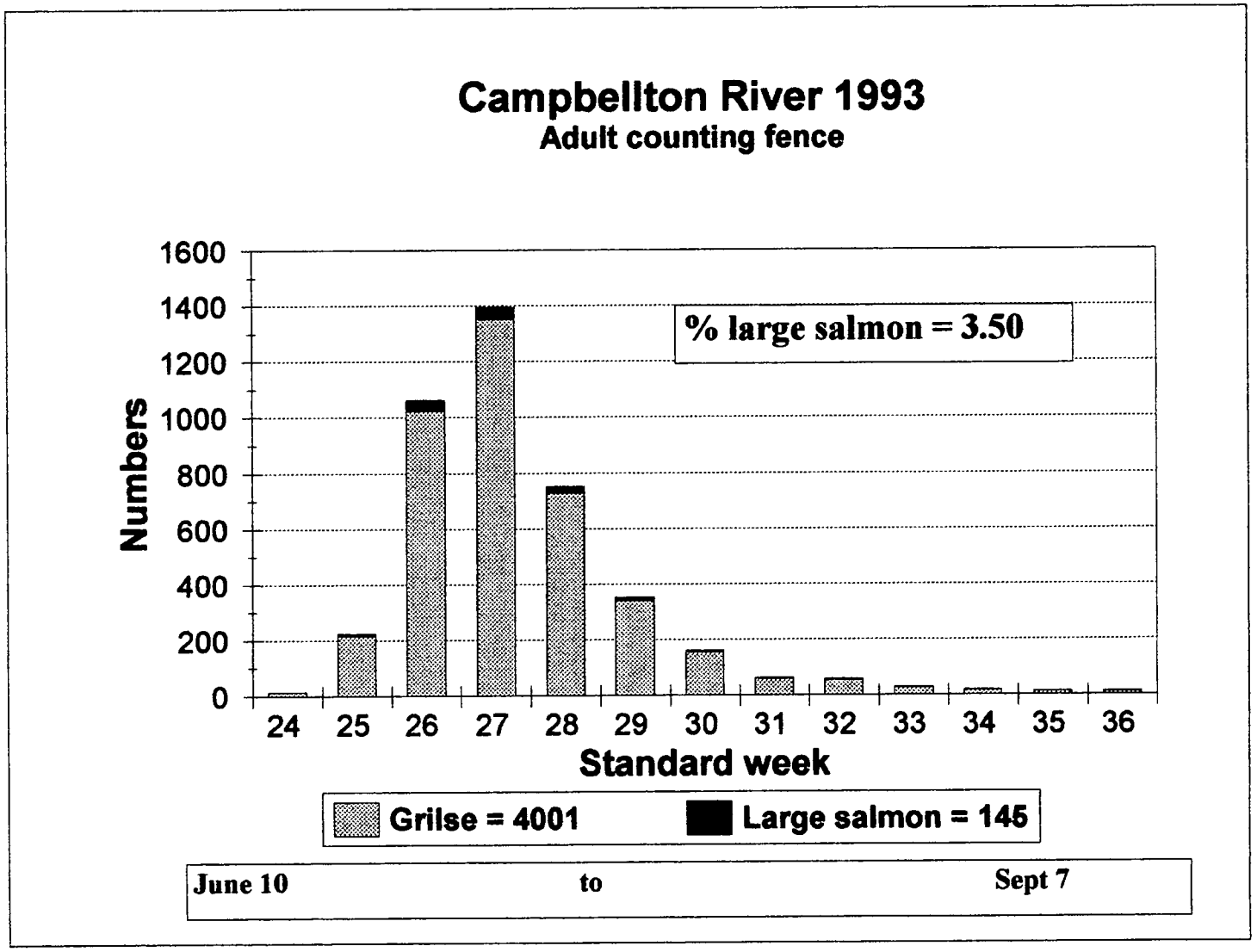
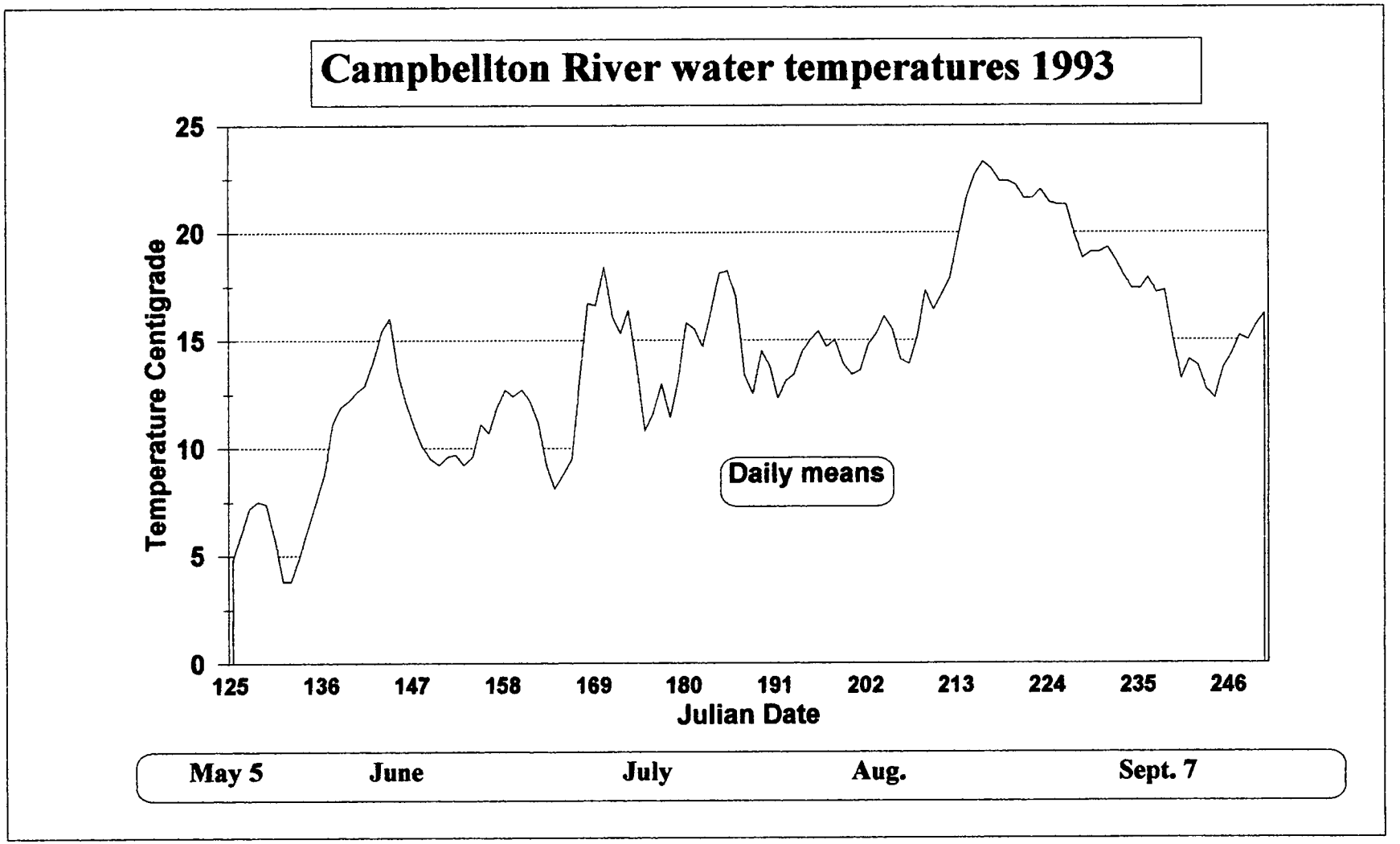


Figure 5. Daily mean water teperatures from the Campbellton River, 1993.



Appendix A. Commercial and Recreational Atlantic salmon season and quota regulations in Newfoundland and Labrador, 1993.

SFA 4 Notre Dame Bay

Commercial Fishery

Waters	Opening / Closing Dates
All costal waters from Cape St. John to Cape Freels	Closed

Recreational Fishery (Small salmon)

Area Quota: 4,800 fish

Area quota split *: 3,360 fish (June 19 to July 31)
1,440 fish (August 1 to September 6)

Individual quotas (Province wide):

Season bag limit - 8 fish
Daily bag limit - 1 fish
Possession limit - 2 fish
Hook & release limit - 4 fish

Seasons

River	Opening / Closing Dates
All rivers running into the coastal waters between Cape St. John and Cape Freels with the exception of the following:	June 19 - September 6
Indian River, including Burnt Berry Brook	June 19 - August 29
Exploits River and its tributaries	June 19 - August 29

* The area quota was split on an 70/30 percentage basis, using the five-year mean (1985-1990) angling catch statistics.